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Pennsylvania Geological Survey

Fourth Series

The ANNVILLE, MYERSTOWN and HERSHEY FORMATIONS of PENNSYLVANIA

By

C. E. Prouty

COMMONWEALTH of PENNSYLVANIA

DEPARTMENT of INTERNAL AFFAIRS

Genevieve Blatt, Secretary

TOPOGRAPHIC and GEOLOGIC SURVEY

Carlyle Gray, State Geologist

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The

ANNVILLE, MYERSTOWN, and HERSHEY

FORMATIONS of PENNSYLVANIA

By

C.E.Prouty

ABSTRACT

The indefinite status of the "Leesport Formation" of Pennsylvania has prompted a study of the distribution, stratigraphic position, and composition of the rocks mapped under this name. Inconsistant mapping of the "Leesport" apparently reflects the structural and lithologic complexities of the type section at West Leesport, Pennsylvania. Indeed the inconsistencies involving the "Leesport" are of such nature as to preclude satisfactory redefinition of the formation.

The rocks comprising the approximate interval of the "Leesport" as mapped by G. W. Stose, are herein assigned new names, from oldest to youngest, the Annville Limestone, Myerstown Limestone, and Hershey Limestone. The "Annville stone", a commercial term used for years in the high-calcium limestone industry is given formal formational status (Annville Limestone). The formation occurs in a relatively narrow strip from near Wernersville to the environs of Harrisburg, where it is believed to rest accordantly on the middle member of the "Stones River" group and to grade westward from Harrisburg into the upper calcilutite member of that "group". The age of the essentially unfossiliferous Annville then must depend on the age assignment of the upper "Stones River", but is provisionally considered late Chazy, pending additional faunal studies of the "Stones River" fauna. The Myerstown Limestone is darker and has a higher clay content than the Annville, upon which it rests accordantly, but with disconformable relationship. It essentially represents the lower Jacksonburg of western New Jersey and the "Cement Limestone". The few fossils found would indicate a lower Trenton age. Southwestward from Harrisburg the Myerstown grades into the Mercersburg Limestone and lower Salona (Oranda) facies. The Hershey Limestone is higher in clay content than the Myerstown and represents essentially the "Cement Rock" of eastern Pennsylvania, and the upper Jacksonburg of western New Jersey. The Hershey has approximately the same distribution as the Myerstown Limestone, from about the Delaware River on the east to the Harrisburg area from whence westward the Hershey equivalent is represented in the dark, dark limestones of the upper Salona Limestone and lower Martinsburg Formation. Lateral relationships with more fossiliferous beds indicate a middle Trenton (Sherman Fall) age.

Abrupt facies changes of the Annville-Hershey rocks in the Harrisburg area point to the continued effectiveness of the "Harrisburg axis" as an important paleostructure in post-Chazy to pre-middle Trenton time. Also, the presence in the Reading area of disconformity beneath the Martinsburg Formation. In addition to data on the distribution of the Annville - Hershey rocks, indicate the presence of a paleostructure in the Reading area, referred to here as the "Reading axis".

*Michigan State University and Cooperating Geologist, Penna. Topographic and Geologic Survey.

INTRODUCTION

Rocks of Middle Ordovician age in central and eastern Pennsylvania have long been the subject of considerable study. That portion of the Middle Ordovician herein assigned to the Annville-Hershey interval has been particularly controversial. The work reported upon was undertaken to attempt a clarification of the more salient points of this controversy.

The field work for this study was done during a portion of the summers of 1949 and 1950 under direction of the Bureau of Topographic and Geologic Survey, Harrisburg. The writer wishes to acknowledge the late S. H. Cathcart, State Geologist, R. W. Stephenson, and Carlyle Gray, the present director of the Topographic and Geologic Survey, for helpful comments in the field. Dr. Gray has accompanied the writer on several occasions and has been of considerable help through his own knowledge of and experience with the rocks in question.

Location of Area

The area covered in this study (Pl. 1) extends from a few miles southwest of Harrisburg northeastward to southwestern New Jersey. Within this area the Middle Ordovician rocks occur in disconnected exposures along the southeast side of the main Martinsburg shale belt which extends from Harrisburg through Allentown to Martins Creek, Pennsylvania and northeastward into New Jersey. The Harrisburg belt ends abruptly along a thrust which cuts a northeastward plunging anticline just east of Harrisburg. Other exposures occur along both the southeast and northwest sides of a second Martinsburg shale belt (Steelton syncline) extending from near Shepherdstown through Steelton to Hummelstown. The belt on the northwest is herein referred to as the Steelton belt; the belt to the southeast, the Hummelstown belt. The latter from Hummelstown eastward forms the main belt extending through Lebanon, Berks, Lehigh and Northampton Counties.

Statement of Problem

The rocks of Trentonian age have been the subject of considerable study in northeast Pennsylvania and southwest New Jersey. Kümmel (1900) mapped the distribution of Trenton limestones in New Jersey over fifty years ago. Kümmel and Weller (1901) later described the Trenton and other rocks in Paleozoic formations in New Jersey, including that of a detailed measured Trenton section at Jacksonburg, Warren County, New Jersey. The rocks of this latter section were called the Jacksonburg Formation in a report by Spencer and others (1900). The Formation was named for rocks hitherto classed as "Trenton" and was correlated with Lowville, Black River and lower Trenton Limestones of the New York section. The Formation at the type locality includes the limestones between the Kittatinny Limestone and the Martinsburg Formation, the same stratigraphic interval of the rocks so extensively used for Portland cement in eastern Pennsylvania. The type Jacksonburg is somewhat similar lithogically to the rock quarried elsewhere for cement, but is considerable thinner. The upper part of the type Jacksonburg consists of dark to black, highly argillaceous limestone. The lower and thinner portion, although partly shaly, contains some highly pure, crystalline beds. This same two-fold division of the rocks can be made southwestward into Pennsylvania.

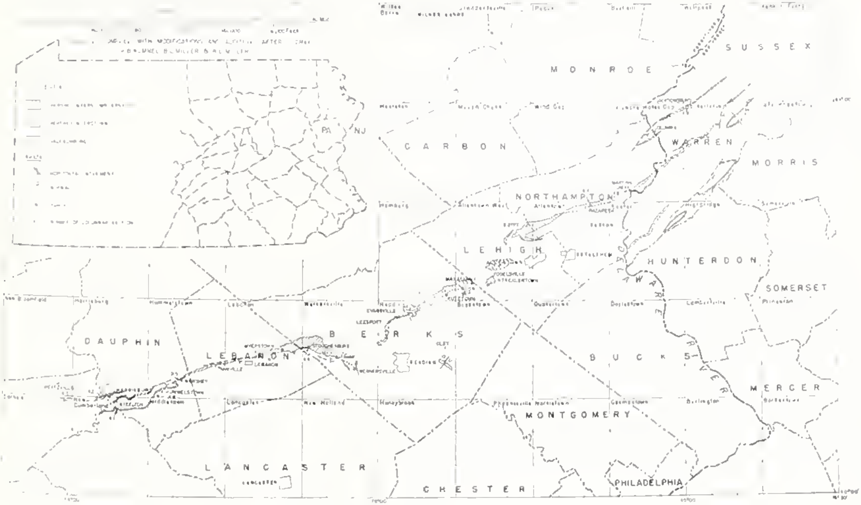


Plate I Distribution Map of the Annville—Hershey Interval.

TABLE 1

Formational Interpretation of Isolated "Leesport" Exposures as shown on the Pennsylvania State Geologic Map

Location of Outcrop	Lithologic Description	Interpretation
Bowmansdale, N.W. rectangle, S.C. part, New Cumberland quadrangle	Finely crystalline, laminated, thin-bedded limestone	Upper Beekmantown
South Harrisburg, at junction of New Cumberland and Harrisburg quadrangles	Dark-gray to black, carbonaceous limestone	Myerstown and Hershey
Main Belt from Hummelstown, Dauphin Co. to Womelsdorf, Berks Co.	Dark-gray to black carbonaceous, thinly laminated, shaly limestone	Myerstown and Hershey
Quittapahilla Cr. 2 miles WNW of Annville, Hummelstown quadrangle	Dark carbonaceous limestone	Hershey
Quittapahilla Cr., 4 miles NW of Annville, Hummelstown quadrangle	Thin-bedded, gray limestone with thin shale partings	Limestone in Martinsburg
2.7 miles NNW of Annville, Hummelstown quadrangle	Thin-bedded, gray limestone with thin shale partings	Limestone in Martinsburg
Union Waterworks, 2.6 miles north of Annville	Thin-bedded, gray limestone	Limestone in Martinsburg
1.3 and 1.6 miles NE of Grantville, Hummelstown quadrangle	Thin-bedded, slabby weathering, gray; alternating with thin shaly beds	Limestone in Martinsburg
Harpers Tavern, Hummelstown quadrangle	Thin-bedded shaly limestone, slabby weathering	Limestone in Martinsburg
Ono, 1.5 miles SE of Harpers Tavern	Thin-bedded, gray, slabby weathering limestone	Limestone in Martinsburg
Fredericksburg and 4 miles west, Lebanon quadrangle	No limestone exposures observed but red and gray shales often observed with limestones in Martinsburg	Martinsburg
Leesport, 8 miles NNW of Reading, Reading quadrangle	Thin-bedded, slabby limestone alternating with thin shales; dark, shaly limestone	Mostly limestone in the Martinsburg; questionable Hershey
Mohrsville, Centerport and half way between, Wernersville and Reading quadrangles	Thin-bedded, gray limestone and thin interbedded shales	Limestone in Martinsburg
Wernersville, Wernersville quadrangle	Dark-gray, thin-bedded and black carbonaceous limestone	Myerstown and Hershey
Evansville, Reading quadrangle	Black, carbonaceous limestone, impure	Hershey "cement rock"
Maxatawny, Allentown West quadrangle	Black, carbonaceous limestone, impure	Hershey "cement rock"
Trexlertown, Allentown West quadrangle	Medium- to dark-gray, crystalline, and black, carbonaceous limestone	Myerstown and Hershey
Fogelsville, Allentown West quadrangle	Dark-gray, finely crystalline limestone and calcarenite; black, carbonaceous, impure limestone	Myerstown "cement limestone" and Hershey "cement rock"
Coplay, Egypt, and Cementon, Allentown West quadrangle	Dark-gray crystalline limestone, black, carbonaceous, impure limestone	Myerstown "cement limestone" and Hershey "cement rock"
Oley Valley, $\frac{1}{2}$ mile S of Oley, P.O., Reading quadrangle	Dark-gray cyrstalline thin-bedded limestone with thin shale partings	Limestone in Martinsburg
Oley Valley, at Limekiln community, Reading quadrangle	Dark-gray, aphanitic to very finely crystalline high calcium limestone and black carbonaceous impure limestone	Myerstown and Hershey limestones

In Pennsylvania, Wherry (1909) assigned the name "Nisky" to the lower beds and Nazareth" to the upper. Later, Peck (1911) called the lower unit the "Nazareth" and ne upper, the "Lehigh". Neither Wherry nor Peck referred to the Jacksonburg Limestone. enjamin Miller (1925) recognized a two fold division of essentially the same rocks in the llentown quadrangle, Pennsylvania, calling the lower part the "cement limestone", and ne upper part the "cement rock". Ralph Miller (1937) retained the name Jacksonburg for nese rocks in New Jersey and eastern Pennsylvania but recognized the lower "cement mestone" facies and the upper "cement rock" facies. He did not favor formal member esignation for these two facies stating that "their limits have not been accurately estab-shed, and the lithologic boundary probably transects time lines."

Stose and Jonas (1927) mapped argillaceous limestones in Pennsylvania between ne Susquehanna and Lehigh Rivers that have the same stratigraphic position as the Jack-onburg, below the Martinsburg and above the Beekmantown. Because of the uncertain elationship of these limestones to the stratigraphically similar Jacksonburg to the north-ast and the Chambersburg to the southwest of the Susquehanna River, they assigned the ame Leesport Formation to these rocks.

Recent work by the writer has indicated some more definite relationships be-veen Stose's Leesport and the Jacksonburg Formation which will be discussed later. The Leesport" has not been mapped consistantly and has been variously assigned to several fferent units. The type section of the "Leesport" is highly complex and so problematical at comparative studies cannot be made successfully. Rather, such comparisons must made with those units most consistantly mapped by Stose as Leesport. Table 1 shows e writer's analysis of the various exposures mapped by Stose as Leesport on the 1932 lition of the Pennsylvania State Geologic Map.

Thus it appears the Leesport as defined and mapped should not be considered valid formation and should either be redefined or renamed. For the sake of clarity d to obviate additional confusion through continued use of the term "Leesport", it ould appear best to assign new nomenclature.

The interval between the Beekmantown Group and the Martinsburg Formation, nbodying essentially the Leesport in east central Pennsylvania and in a restricted sense, e Jacksonburg of eastern Pennsylvania and western New Jersey, may be divided into ree lithologic units, the Annville, Myerstown, and Hershey Limestones. They will discussed in that order, from the oldest to youngest.

STRATIGRAPHY

Annville Limestone

Definition and type section

The name "Annville rock" and "Annville stone" has been used as a trade name for the high-calcium limestones quarried in the Hershey-Annville-Palmyra-Myerstown area for a number of years. Though Miller (1925) has used the name in a formational sense (Annville Limestone) it was apparently proposed as a trade name. There has, then, been no formal formational designation for these rocks to date. The name "Annville" should be retained because of its common commercial usage and the writer proposes the formational name Annville Limestone for these rocks.

The Annville rests on the Beekmantown Group throughout most of its extent. However, in the Harrisburg area, the Annville rests on rocks similar to the middle member of the "Stones River" (Fig. 1). This would imply that the Annville has the stratigraphic position of the upper "Stones River" and therefore is of Chazy or younger age. The Annville occurs beneath the Myerstown Limestone in all observed sections.

Figure 1. Middle "Stones River" about 0.5 mile west of the county farm and about 300 feet north of Cameron Parkway, Harrisburg. The limestone though highly metamorphosed retains some of the characteristics of more typical middle "Stones River" a half mile to the west.

The Annville Limestone was named for the town of Annville, Pennsylvania, located in the general area of the important high-calcium limestone industry. The type section was selected from the quarry at the old Palmyra Plant of the H. E. Millard Limestone Company, about 1.5 miles northwest of Palmyra (Sec. 1). Here the Annville

onsists largely of high-calcium limestone of three types: light-bluish-gray, whitish-eathering limestone; white, marbleoid limestone; and dark-bluish-gray to black, ccasionally carbonaceous limestone. The rock quarried comprises essentially the iickness of the formation, the footwall being the approximate bottom of the younger [yerstown Limestone (beds overturned and dip southeast).

Figure 2. Annville limestone at the abandoned H. E. Millard quarry at Millardsville. Note the "fluting" along the vertical joint surface.

Character and distribution

The type section well illustrates the general lithology of the Annville. In ost places, a light-gray, somewhat mottled appearing limestone with thin, bluish-gray, ther widely-spaced laminae occurs near the base of the formation. Much of the lime-one is grayish, but upon fracture commonly assumes a lighter-gray color, yielding a e sugary or "frosted" appearance. A phenomena often observed in the Annville is ype of differential weathering whereby very fine laminae, numbering several to the :h, weather faster than the general outcrop face, forming minute depressions to give 'fluted" appearance (Fig. 2). This is the reverse of the more common tendency in differential weathering of limestones for the fine laminae to weather into relief. roughout the Annville, but more commonly in the lower portion, occur dense, vari-ored limestones referred to here in the economic sense as marble or marbleoid beds. e rock is white but often has a pink, blue, or sometimes yellowish mottled appearance, l a thin, mottled zone containing broad, bluish-gray laminae often occurs in the basal ls (Fig. 3). Much of the upper Annville is dark-bluish-gray to black, yet is of high cium content as in the lower, lighter gray rock.

Figure 3. Basal beds of the Annville Limestone 0.6 mile south of Swatara Creek along the Hummelstown- Middletown Road. The light-gray to nearly white rock is typical of the high calcium Annville Limestone in the lower part.

The Annville Limestone is distributed essentially in the area between the Susquehanna River on the west and the Lehigh River on the east. The westernmost exposure of definite Annville observed occurs along the west bank of the Susquehanna, directly downstream from Lemoyne. Here, the Annville is exposed along the Steelton belt on the north limb of the overturned Steelton syncline. The rocks are best exposed along the rock ledges into the Susquehanna River, but only when the river is at its lowest seasonal level. Both the light-varicolored marbleoid beds and the dark-blue-gray facies are represented. However, calcilutites of the upper "Stones River" type also occur, the impure and cherty middle member of the "Stones River" being subjacent to the north. The significance of the apparent lateral change to the upper "Stones River" facies in the Harrisburg area is discussed under a later heading. At this outcrop both the lower contact with the Beekmantown, and the upper contact with the Myerstown appear conformable

On the east side of the Susquehanna River the Annville is exposed in several places on both flanks of the Steelton syncline between Steelton and Hummelstown where the Syncline ends (Pl. 1). Along Spring Creek and Cameron Parkway, between Steelton and Harrisburg (New Cumberland quadrangle) the Annville marble and bluish-gray facies are exposed directly east of the intersection with State Highway 541. The "Stones River" Limestone occurs directly below, forming a wide belt to the north to Highway 322 and 422 where a large quarry (Hoffman Brothers and Wilson) has produced for years from this rock and the uppermost Beekmantown dolomite.

A good exposure of lower Annville occurs in the roadcut of Highway 322 and 422 directly east of the bridge over Spring Creek, about 2.5 miles east of the Capitol building

ı Harrisburg. Here, a few thin dolomite beds occur in the marble beds. The under-
ring "Stones River" is found directly north of the road in a large abandoned quarry,
ow the city dump. A few scattered outcrops of higher Annville occur in the field to the
outh of the highway. This is the most northerly exposure of the Annville observed
ı this area. Along Reservoir Hill road, a few hundred feet north of the main street of
axtang, the Hershey Limestone is in direct contact with dolomite thought to be Beek-
ıantown. The writer believes that this anomalous contact is due to displacement along
.e Paxtang thrust fault.

Figure 4. Dolomite conglomerate zone in basal Hershey Limestone at west end of quarry at Section 3.

The Annville is largely covered eastward along the Steelton belt to the end
nır Hummelstown. A small abandoned quarry exposes a few feet of Annville in a field
d ectly south of the old airport, about one mile southeast of Paxtang.

On the south side of the Steelton syncline in the Hummelstown belt, the pre-
Anville "Stones River" is absent and the Annville rests directly on the Beekmantown.
Tis relationship makes the drawing of the Beekmantown-Annville contact more difficult
d to the similarity of much of the Annville and Beekmantown lithology. The principle
c terion for recognizing the contact is the first downward occurrence (stratigraphically)
o nassive dolomite beds, of upper Beekmantown age (probably an eastward continuation
o he Bellefonte Dolomite of Central Pennsylvania). This contact is readily drawn in the
m in Annville belt (eastward extension of the Hummelstown belt) from Hummelstown to
L banon. Here the massive dolomites form the hanging wall (beds overturned and dipping
t he southeast) of the high-calcium limestone quarries.

At the large Bethlehem Steel Company quarry in south Steelton along the Susquehanna River, the Annville-Beekmantown contact can be drawn only approximately because of the poor development of the massive dolomites (Sec. 2). Along Laurel Run, 0.8 miles northwest of Highspire and about 1.5 miles east of the Bethlehem Steel Company quarry, about the same section is present as at the latter. In the smaller of two quarries occurring several hundred feet northwest of where Laurel Run crosses under the Highway 322 Cutoff to the Harrisburg East Interchange of the Pennsylvania Turnpike, silty, gray-brown and medium-gray, coarsely laminated beds are thought to represent transitional beds of the Annville-Myerstown contact. These beds will be discussed additionally in the Millardsville Section.

The Annville is exposed (78 feet) in the abandoned quarry along Swatara Creek and the Hummelstown-Middletown road, 1.8 miles southwest of Hummelstown (Sec. 3). Both the upper and lower contact are exposed, the latter showing a 15°-20° discordance with the massive dolomites of the upper Beekmantown. The Beekmantown surface shows several feet of relief. A recent reopening of this quarry (Ebersole Brothers) and an extension subparallel to the strike of the Annville and Beekmantown reveals considerable folding and faulting previously unobservable. The above Annville thickness must now be considered approximate and some doubt is cast on the Annville-Beekmantown discordance as other than a fault contact. However, the basal Annville mottled beds are present, and an unfaulted discordance appears possible. Also, the discordance between the Annville and Beekmantown was observed in the Ebersole quarry, one mile south of the above sectic along the Middletown road. The Hummelstown belt is overturned to the north throughout its extent so that the Beekmantown forms the hanging wall in the above and other quarries of the belt. Marble in the Beekmantown, highly similar in appearance to that in the Annville, occurs in a broad area to the south, in places nearly to the Triassic border fault. This marble is often of high lime content but alternates with dolomites and impure magnesian limestones. In places, the Conococheague Formation, containing some pink marble beds similar to some in the Annville, occurs south of the Beekmantown and adjacent to the Triassic border faults. The massive dolomites occurring at the top of the Beekmantown and forming the hanging wall in the high-calcium quarries are of great stratigraphic significance in drawing the lower Annville boundary, especially where exposures are few in the broad Beekmantown belt.

One mile west of Hershey along Highway 422, the old Swatara Plant of the H. E. Millard Lime and Stone Company operated a deep quarry in about 100 feet of Annville (Sec. 4). No white marble was observed here. The Annville-Myerstown contact occurs about at the footwall of the quarry. To the east of the type section, the Annville is quarried at the main workings of the H. E. Millard Company just west of the town of Annville. It is also quarried along Highway 422, halfway between Lebanon and Myerstown by the Calcite Quarry Corporation. Directly southeast of Millardsville, about two miles east of Myerstown (Lebanon quadrangle), the marble and higher bluish-gray facies are exposed in a large abandoned quarry of the H. E. Millard Company. Along the northern extension of the quarry, the uppermost Annville shows a banded appearance, apparently due to high clay content of the bands, which on weathering become slightly buff-gray. This zone is somewhat transitional into the Myerstown Limestone.

A few small outcrops of Annville are exposed along the road and adjacent fields leading north from the bridge where old Highway 422 crosses Tulpehocken Creek (Wernersville quadrangle).

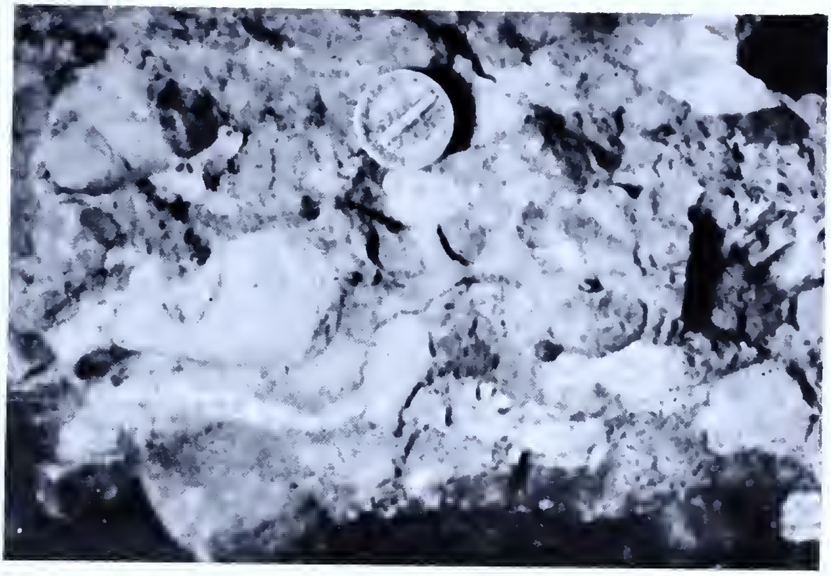


Figure 5. Dolomite conglomerate from locality shown in Fig. 4. Note rounded to sub-angular pebbles and cobbles.

The Annville disappears northeastward along this belt near Wernersville, the Beekmantown being in contact with the Martinsburg Formation. However, the Annville does reappear in Oley Valley, six miles east of Reading. The rapid disappearance of the Annville, Myerstown, and Hershey in this area might infer displacement by faulting. However, northeastward along the belt no unquestioned Annville was observed, and the Beekmantown is in apparent accordant contact with either the Myerstown-Hershey (Jacksonburg) or the Martinsburg. One might infer a regional disconformity in this case. Considerable relief exists in places where the Martinsburg Formation rests on the Upper Cambrian Conococheague in outliers near Reading. The significance of this break is discussed later. A questionable exposure of Annville occurs directly south of the crossroads at Churchville community (Easton quadrangle). Here the limestone is bluish-gray, pure, much like the upper Annville to the west.

Age relations

The Annville rests with apparent conformity on the middle member of the "Stones River" Group in the Harrisburg area (Fig. 1). West of Harrisburg the "Stones River" is divisible into a lower unit consisting principally of dark, chalky-weathering calcilutites; a middle unit of dark-gray, fine- to medium-crystalline, argillaceous, nodular limestone; and an upper unit much like the lower dark, chalky-weathering calcilutites. The writer considers the Annville to be a laterally gradational equivalent of the upper unit of the "Stones River" for the following reasons: (1) the upper "Stones River" disappears eastward in the Harrisburg area where the Annville lithology begins; (2) they have the same stratigraphic position; (3) the Annville lithology, especially the marble beds, are essentially calcilutites; and (4) the occurrence of occasional *Maclurites*

in both. None of these points taken singly is conclusive, but together, they offer rather strong evidence. The Annville would then appear to be upper "Stones River" and therefore presumably late Chazyan or Black River in age. Work on the faunal age relationshi in the "Stones River" is now in progress by the author. Since the balance of the "Stones River" Group disappears directly east of Harrisburg (Prouty, 1951) the Annville rests disconformably upon the Beekmantown with possible slight discordance in places (Sec. 3)

Figure 6. Exposure in road cut along Highway 11 at Lemoyne, across the Susquehanna from Harrisburg. Here, the upper Mercersburg Limestone (on the left) is in contact with the Oranda Limestone (lower Salona). Both facies end abruptly in the Harrisburg area, grading into the upper Myerstown and lower Hershey lithology. The beds are overturned, and dip south.

The Annville-Myerstown contact appears accordant in the field although a hiatus may exist equal to part of the Black River group of the New York section. More will be said later concerning the age of the Myerstown and lower Jacksonburg.

Myerstown Limestone (new)

Definition and type section

The Myerstown Limestone was named from exposures in the general vicinity of Myerstown, Lebanon County, Pennsylvania. The type section, however, was chosen from exposures in and adjacent to the quarry 1.8 miles southwest of Hummelstown, Pennsylvania, where the Hummelstown-Middletown road crosses Swatara Creek (Sec. 3). Despite the faulting and folding observed in this quarry (see discussion of the Annville from this section) it is believed that the Myerstown has not been involved in faulting that would eliminate or repeat any of the section. The base of the Myerstown is fairly sharpl defined in the quarry where the dark, platy Myerstown contrasts to the lighter, more massive beds of the Annville. At the top, the Hershey contact is marked by a limestone and dolomite pebble conglomerate occurring directly west of the quarry near the highway

Figure 7. Myerstown Limestone in road cut along Good Street between Chambers Street and the large Bethlehem Steel quarry at Steelton, Pennsylvania.

Fig. 4), and along the highway at the first curve a few hundred feet south of the quarry. [he Myerstown here at the base is a rather typical dark-blue, slabby, dense to fine-;rained limestone. Higher in the section the limestone is dark, carbonaceous, and quite ;haly (with some slaty cleavage), slightly like the overlying Hershey, but distinguished rom it largely in the alternating shaly and limy, dark-gray beds rather than the homo-;eneous, black, argillaceous limestone of the Hershey. Also the Hershey almost invari-.bly possesses well developed slaty cleavage, with the bedding usually obliterated. The nost characteristic feature of the Myerstown is the tendency to weather into thin slabs vhich, because of its dense, compact texture, gives a ringing sound when struck with the ıammer. This characteristic also occurs in the Mercersburg, a partial equivalent west ›f Harrisburg (Figs. 6 and 7). A secondary feature often found in the Myerstown is nilky quartz which occurs in slender columns (Fig. 8). Similar quartz is found in small .mounts in the Hershey Limestone and Martinsburg Formation. The quartz, where .bundant, usually indicates the Myerstown. The quartz concentrates in the residual soil, o the feature is particularly helpful in mapping where outcrops are sparse. The columnar uartz was observed at this horizon from several miles west of the Susquehanna River, vhere it grades into the upper "Chambersburg " facies, to easternmost Pennsylvania, vhere it occurs in the "cement limestone" facies of the Jacksonburg Limestone. Another eature of the Myerstown, having about similar distribution as the columnar quartz, is peculiar fret-work occurring in a cross-pattern (Fig. 9), possibly due to differential olution along planes formed by the intersection of joints and bedding laminae. It is ifficult to understand the apparent stratigraphic occurrence of these markings unless the articular composition and compactness of the Myerstown is conducive to their develop-ıent. This feature of the Myerstown has proved very helpful in identifying the formation. he Myerstown has several metabentonite beds. All are thin except the uppermost bed hich locally may be six to eight inches thick.

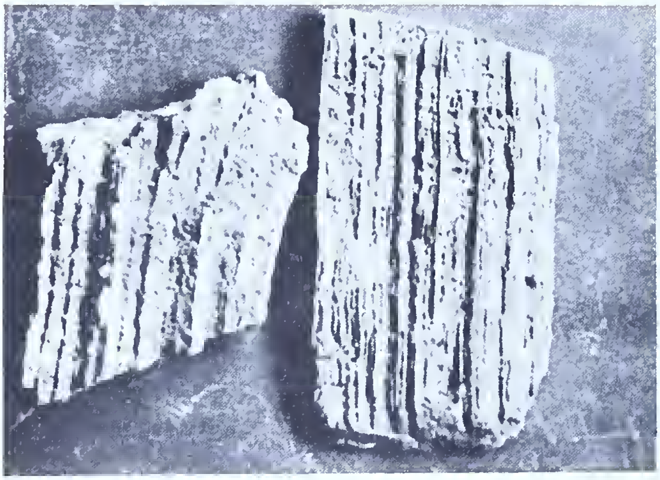


Figure 8. Columnar quartz from the Myers-town Limestone.

Figure 9. Slab-like Myerstown limestone showing "fret-work" weathering. From road cut at Millardsville.

Character and distribution

The Myerstown Limestone was observed as far southwest as the Harrisburg region. No outcrops were observed in the Harrisburg belt, the absence probably due to faulting, but in the north Steelton belt the formation occurs in a few scattered exposures in the field south of Highway 422 where it crosses Spring Creek, about a half mile south of Paxtang.

At the Bethlehem Steel Quarry in South Steelton (Sec. 2), the Myerstown Limestone is exposed along a small alley leading north from the northwest end of the quarry. Here, (with some folding) approximately 240 feet of dark, slabby, fairly pure limestone was partially exposed between the quarry and Chambers Street. Near the top, there is about twelve inches of greenish-gray metabentonitic clay. Similar metabentonitic clays were observed at this same approximate position in several sections to the east. Another metabentonite, one - two inches, occurs about fifty feet above the base. Directly northeast of the junction of Chambers and Good Streets, perhaps 25 to 30 feet stratigraphically above (beds dip south but are overturned) the thick metabentonitic shale layer, occurs a dolomite pebble conglomerate at the base of the Hershey Limestone. One dolomite boulder several feet in size was observed. This is considered to be the same conglomerate zone observed near the Myerstown-Hershey contact at Swatara Creek (Sec. 3).

Along Laurel Run, 0.8 miles northwest of Highspire, the transition beds occurring at the Myerstown-Annville contact are exposed in the small quarry directly east of the main quarry. The Myerstown-Hershey contact is exposed along the old road directly east of, and parallel to Highway 230 By-pass at the community of Churchville on the New Cumberland quadrangle. Here, the slabby, dense, dark Myerstown can be contrasted with the slaty-cleaved, clay-rich Hershey. No limestone conglomerate was observed in the basal Hershey here.

At Hershey (Sec. 4), the lower 65 feet of Myerstown are exposed along the west end of the old H. E. Millard quarry. A large colony of bryozoa (*Prasopora*) was found in a float block 28 feet above the base. Several unidentifiable brachiopod fragments were found about 60 feet above the base. The Myerstown-Hershey contact is in a covered zone north of the quarry.

At Millardsville (Sec. 5) the lower Myerstown contact is exposed in the north extension of the old H. E. Millard quarry. *Prasopora* cf. *P. simulatrix* Ulrich was collected about 10 feet above the base.

The higher beds are well exposed along the cuts in the road leading from Millardsville to Highway 422, several hundred feet north of the quarry. This exposure was selected as a standard section for the Myerstown as it illustrates its principle features such as the residual columnar quartz; the "fret-work" weathering phenomena; the typical slabby weathering; the dense compact nature (often yielding a metallic ring when struck); the rough travertine and crinoidal covered surfaces; and the occasional dark, coarsely crystalline beds. This represents one of the few Myerstown sections that produced other than entirely fragmented fossils. The following were identified from the small collection: *Echinosphaerites aurantium* (Gyllenhal), *Dinorthis* cf. *D. pectinella* Conrad), *Diplotrya? appalachia* (Bassler), *Rhinidictya* sp., *Valcourea* sp., and many crinoid columnals.

An exposure of the upper Myerstown occurs at the first cross-road one mile east of Stouchsburg along new Highway 422 (Sec. 6). Here, three, possibly four metabentonites can be observed in the soil in the north embankment. The thickest bed, eleven inches, is thought likely to represent the thick metabentonite zone occurring at the Steelton section (Sec. 2), occurring in both areas about 50-100 feet below the basal Hershey conglomerate.

A small exposure of Myerstown occurs along Highway 422 directly north of Gauls quarry (south central part of central rectangle, Wernersville quadrangle). The Myerstown disappears eastward along this structural belt. The Annville is likewise absent, probably due to the same reason, faulting or disconformity. The reappearance of the Myerstown in Oley Valley (east central rectangle of the Reading Quadrangle) may have some bearing on the structural picture in the general Reading area and will be discussed later.

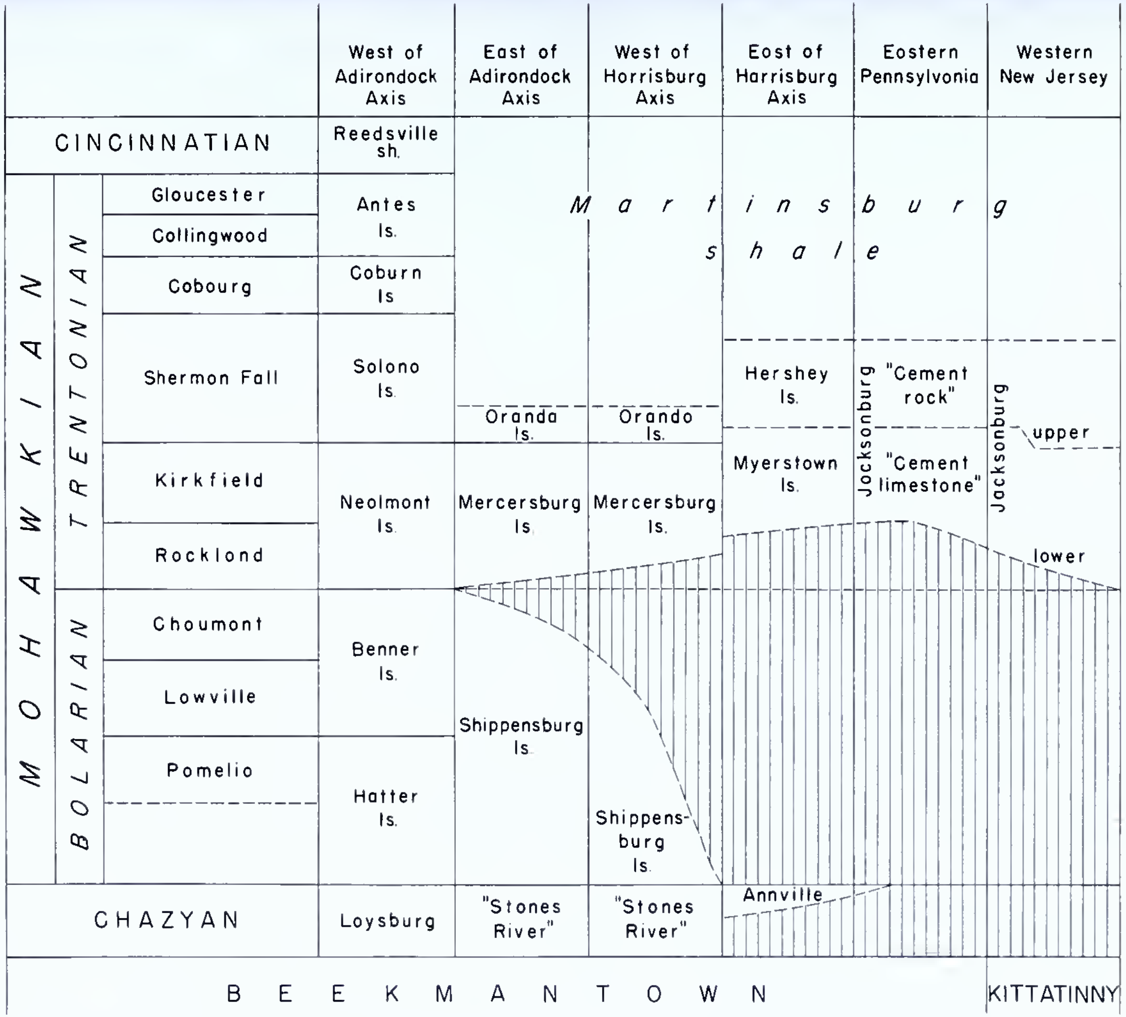
In the small quarry 1.4 miles northwest of Trexlertown, a few feet of limestone believed to be Myerstown occurs near the top. The shaly appearance is quite similar to the Hershey Limestone, but contains less clay, and is usually gray to dark-gray, rather than consistantly black. Crystalline limestone beds observed locally in the Myerstown west of the Schuylkill River become quite prominent in this area.

Most of the large Portland cement quarries of the Allentown-Egypt-Bath-Nazareth region are largely developed in the Hershey limestone. However, in the Lone Star Quarry, in West Nazareth (Allentown quadrangle) the "cement limestone" (Myerstown), as mentioned by Ralph Miller (1937) is exposed along the south side of the quarry. Here, the upper 100 feet of fairly pure, dark-gray, dense to crystalline Myerstown is exposed. The Myerstown apparently continues to become more crystalline eastward. The limestone here contains great amounts of the columnar quartz, typical of the Myerstown Limestone to the west. The Hershey Limestone above is readily distinguished due to the uniform aphanitic texture, black color, and prominent slaty cleavage.

In the east part of Nazareth, the Nazareth Cement Company quarry exposes some of the Myerstown beds. These beds are fairly pure, some reportedly showing analyses up to 90-95% $CaCO_3$. As in the Lone Star Quarry, the purer limestone is occasionally used to "sweeten" the "cement rock" to obtain the correct blend for Portland Cement. East of here, the Myerstown was not observed in any good exposures.

At Martins Creek, *Prasopora* was found in abundance near the base of the exposed beds in the Alpha Cement quarry. Unlike the Nazareth and Lone Star quarries, most quarries in this region have confined nearly all the operations to the Hershey "cement rock".

At the type section of the Jacksonburg (Sec. 7) east of the Delaware River in western New Jersey, a definite break occurs below the *Prasopora* beds of the basal "cement rock". Below, the beds are much purer and contain some coarsely crystalline beds that, although they are coarser, are somewhat similar to those of the Myerstown "cement limestone" to the west. However no platy, dark, limestone characteristic of the Myerstown facies was observed. On the basis of the above partial lithologic comparison, stratigraphic position, the generally much purer composition of these beds, and position subjacent to the persistant *Prasopora* zone, they are considered by the writer equal, at least, in part to the "cement limestone" and Myerstown Limestone



Correlation Chart of Middle Ordovician Equivalents

Figure 10

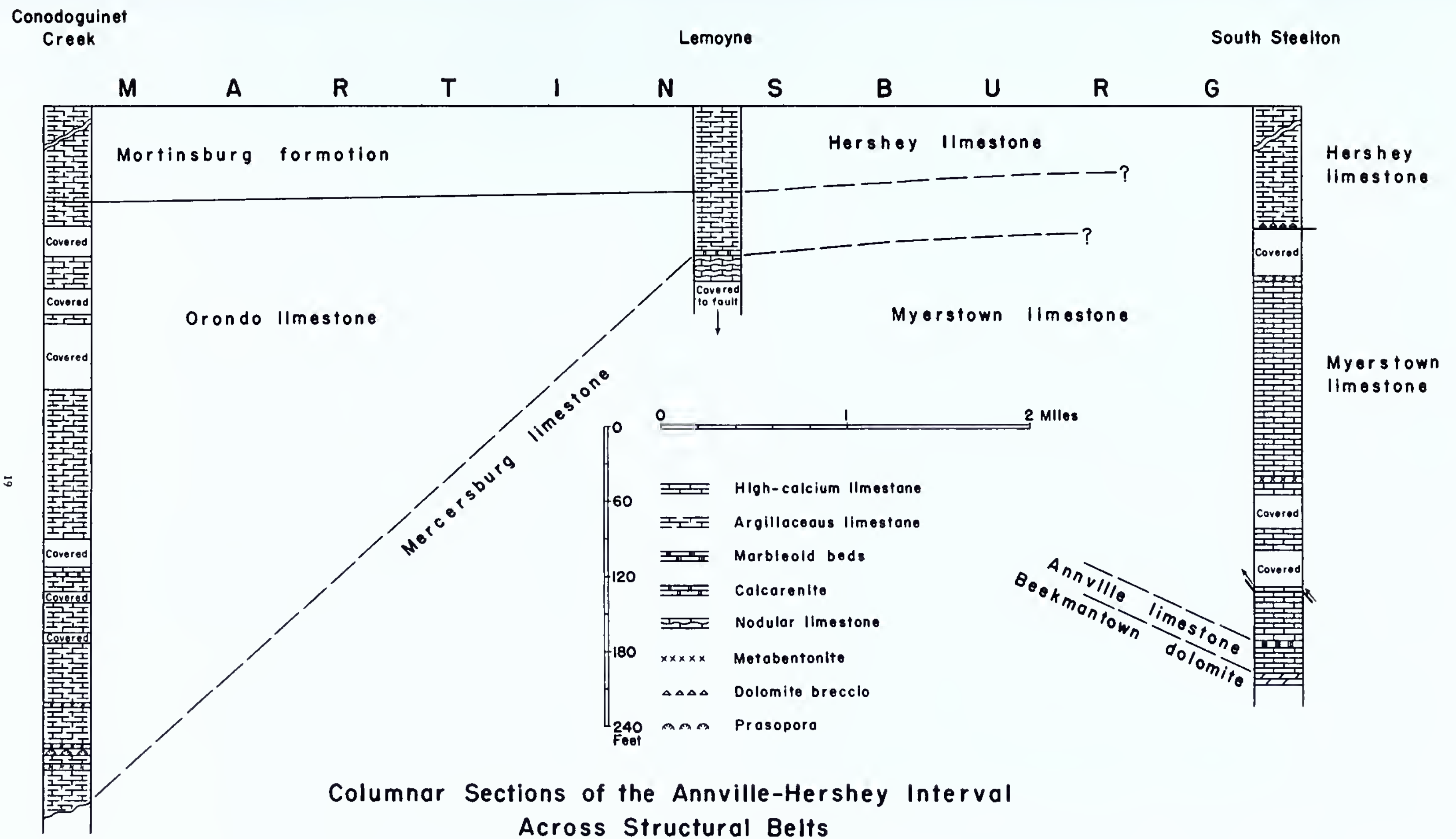
west of the Delaware River in Pennsylvania. However, major differences in some lithologic characteristics of the two, in addition to some faunal differences, discussed later, infer that some of the lowest Jacksonburg beds may largely disappear in eastern Pennsylvania (Fig. 10).

Age relations

Very few identifiable fossils were found in the rather highly metamorphosed Myerstown Limestone. The lowest occurrence of *Prasopora* appears to be in the upper Myerstown Limestone, although only occasionally are they found this low. A more prolific zone believed to persist from western New Jersey to at least Womelsdorf (west central rectangle of the Wernersville quadrangle), is in the Hershey "cement rock" type lithology near the base. The lowest occurrence of this form at the Jacksonburg type section is in the lower part of the "cement rock" facies which is considered of Hull (Trenton) age by Ralph Miller (1937) and lower Trenton by Weller (1903) on the basis of the associated fauna. The lowest occurrence *Prasopora simulatrix* (variety *orientalis*) beyond the western extent of the Myerstown facies is in the Oranda Limestone (basal Salona Limestone). The Oranda is considered by Craig (1949) equal to that part of Salona Limestone of central Pennsylvania which occurs below Salona Metabentonite 2. The base of the Oranda is thought no older than Sherman Fall (middle Trenton).

Echinosphaerites, observed in the Myerstown of the Millardsville section, occurs abundantly in the Oranda, but has not been reported from the Jacksonburg. *Dinorthis pectinella* occurs in the Mercersburg and Oranda Formations to the west and in the lower part of the "cement rock" (upper Jacksonburg). On the basis of the limited Myerstown fauna, a Trenton age is indicated which would infer that the uppermost beds are probably as young as, or possibly younger than, Hull (Kirkfield) in the New York standard, and the lowermost beds of Rockland age. Thus the Myerstown-Hershey contact apparently does not fit exactly the upper and lower Jacksonburg contact of western New Jersey (Fig. 10).

Lithologically, the Myerstown is quite similar to the thin, slabby, dark- to medium-gray beds of the upper "Chambersburg" (the Kaufman Member of the Mercersburg Limestone of Craig (1949), and apparently grades into that facies just west of Harrisburg (Fig. 6). In addition to their similar stratigraphic position and, to a certain extent, lithology, they have in common the columnar quartz, fret-work weathering, and, at times, the "negative fluting" of the Myerstown. The thick metabentonite observed in the uppermost Myerstown at Steelton and Stouchsburg compare favorably in thickness and stratigraphic position with the metabentonite of the lower Salona at Conodoquinet Creek (Sec. 8 and Fig. 11) a few miles west of Harrisburg. This bed may represent the Salona 2 of Rosenkrans (1934). It is placed in the base of the Martinsburg Formation by Craig (1949) in south-central Pennsylvania, and Rosenkrans (1933) in the Shenandoah Valley of Virginia. Since the base of the Martinsburg Formation is generally placed at the top of the Jacksonburg in eastern Pennsylvania and western New Jersey, it is apparent that the basal Martinsburg Formation is not of the same age in different areas. This will be discussed in more detail later. Kay (1944) considers Salona 2 metabentonite to be of basal Martinsburg age, but in central Pennsylvania has found it feasible to divide the Martinsburg equivalents into the Salona Limestone, Coburn Limestone, Antes Shale, and Reedsville Shale. Inconclusive, but highly suggestive evidence based on metabentonites would indicate that uppermost Myerstown might be as young as lower Sherman Fall (Figs. 10 and 12).



Columnar Sections of the Annville-Hershey Interval Across Structural Belts

Figure 11

The Myerstown of eastern Pennsylvania represents the "cement limestone" of B. L. Miller (1934), and is herein used in place of the latter informal designation. Since the "cement limestone" and overlying "cement rock" were defined in terms of the same compositional and lithologic differences that exist between the Myerstown and Hershey, no basic distinction is made between the Myerstown and "cement limestone",

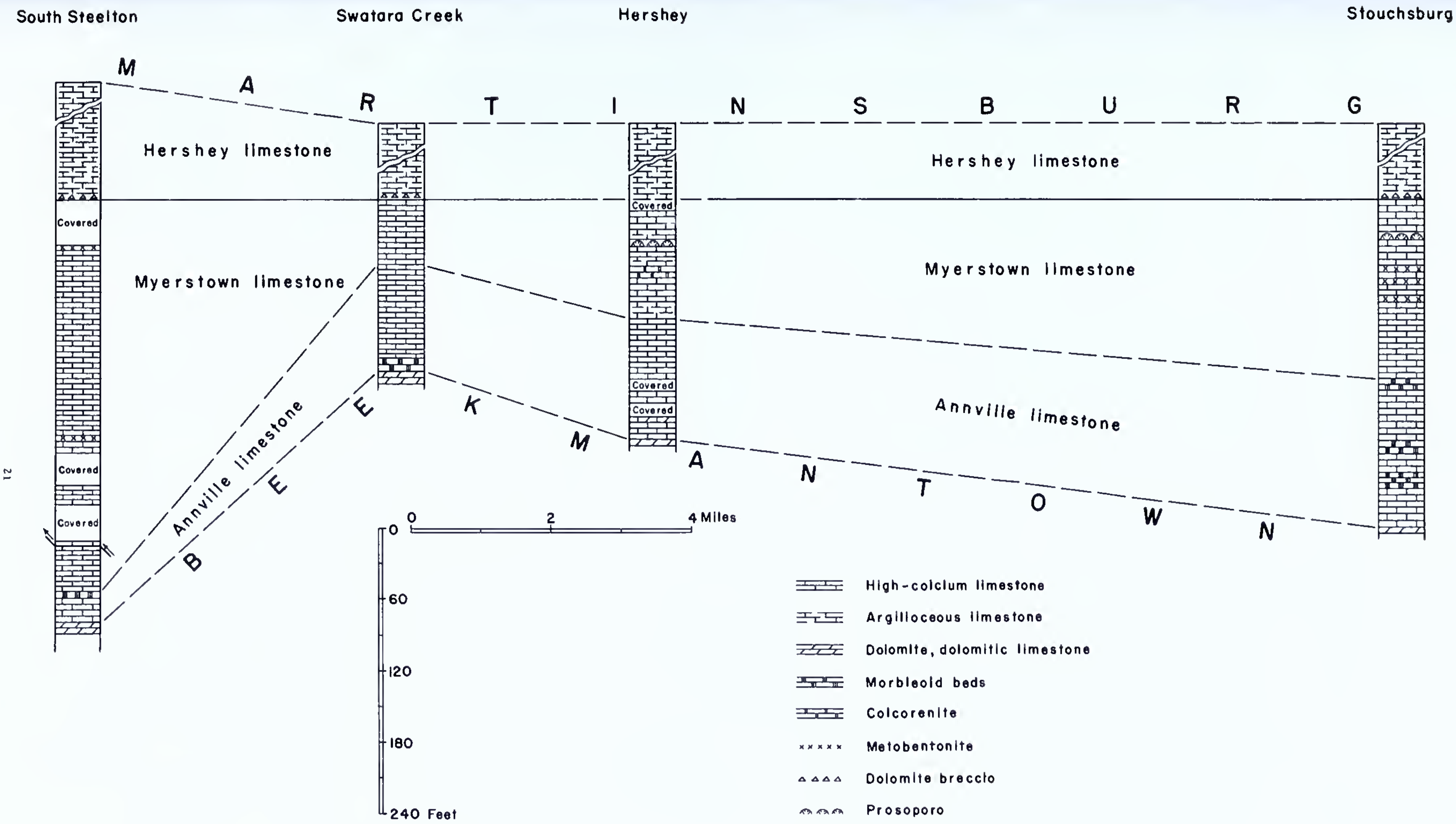
Figure 12. Metabentonitic (?) shale zone in the upper Myerstown Limestone, near the southeast corner of Chambers and Good Street, Steelton.

nor between the Hershey Limestone and "cement rock". Thus, in any one area, the Myerstown - Hershey contact could be considered the same as the "cement limestone" - "cement rock" contact. There is little evidence upon which to assume that the age of this contact changes appreciably from easternmost Pennsylvania westward (Figs. 13 and 14). However, some inference might be made from the apparent lower occurrence of *Prasopora* in the upper Myerstown, than in the basal upper Jacksonburg in western New Jersey. On this basis the uppermost Myerstown might be slightly younger than the highest beds of the lower Jacksonburg. This is negative evidence based on the fact that *Prasopora* has not as yet been reported from the upper beds of lower Jacksonburg. Similarly, the lower contact of the Jacksonburg of western New Jersey would appear older than the lower Myerstown contact in eastern Pennsylvania (Fig. 10) as much of the fauna of the former has not been observed in the latter. Both the upper and lower Jacksonburg in New Jersey are much more fossiliferous than the Myerstown or Hershey and again conclusions must be based on negative evidence.

Hershey Limestone (new)

Definition and type section

The Hershey Limestone takes its name from the town of Hershey near which these limestones are well developed. The type section, however, was selected from the



Columnar Sections of the Annville-Hershey Interval
Along Annville Belt

Figure 13

exposures along Swatara Creek (Sec. 3), also the type section for the Myerstown Limestone.

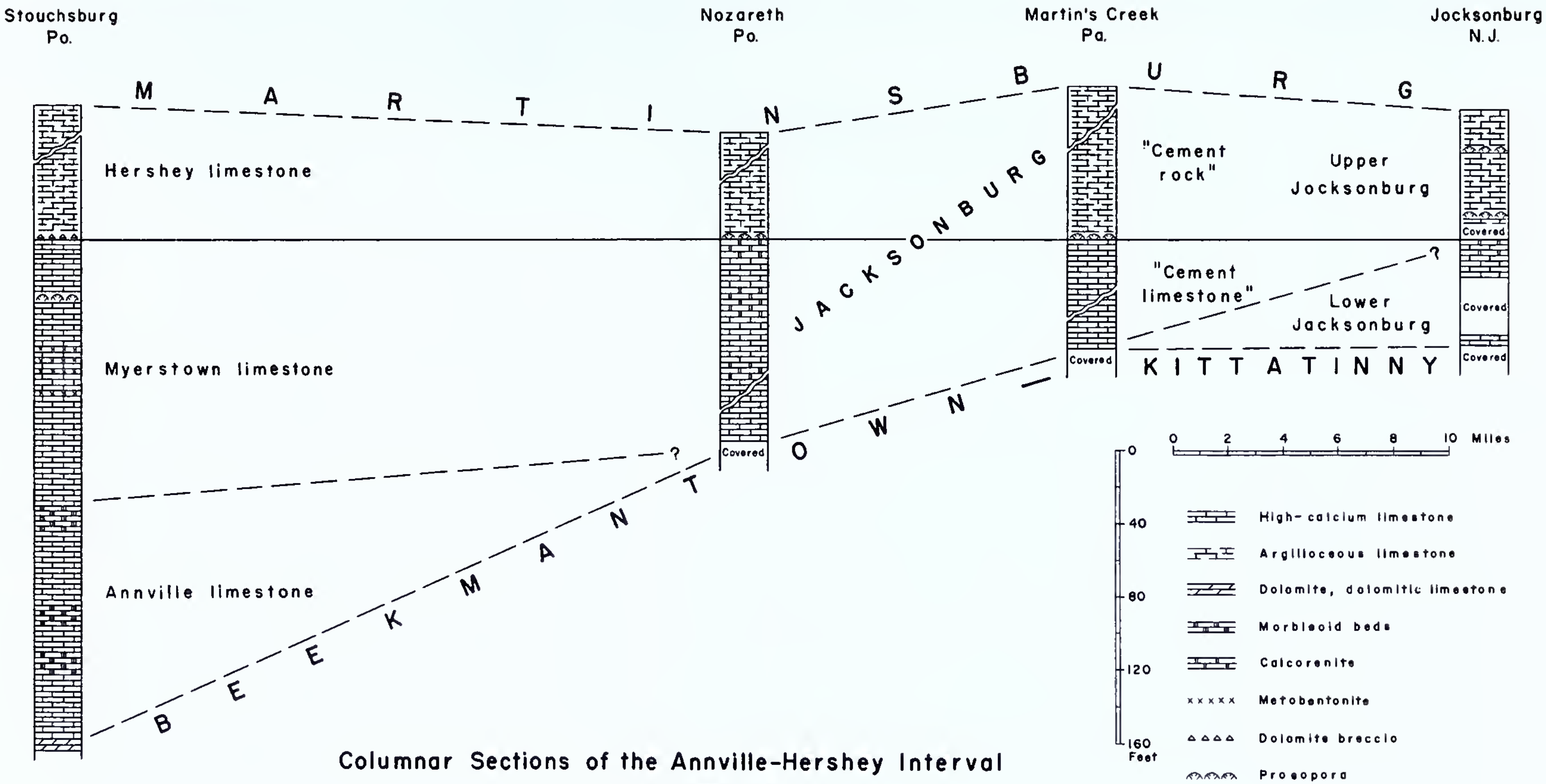
This section represents the most complete observed for the Hershey Limestone. In the lower 10 to 15 feet is a zone of dolomite conglomerate, exposed directly west of the quarry near the highway and in the road cut at the first curve south of the covered bridge across Swatara Creek, along the Hummelstown - Middletown road (Figs.4, 5, and 15). The conglomerate is composed chiefly of angular to subrounded pebbles and cobbles of creamy-gray-weathering dolomite, much like dolomite in the Beekmantown. The great majority of the Hershey is black, carbonaceous, shaly limestone, generally showing well developed slaty cleavage. Considerable dark-gray, limy siltstone occurs throughout the Swatara Creek section, a feature observed occasionally in other sections to the east. Here, as in other Hershey exposures, the thickness cannot be determined because slaty cleavage has largely masked the bedding. A rough estimate is 300-400 feet thick. The upper contact is an approximate estimation, because there is a somewhat transitional relationship with the overlying Martinsburg Formation. Usually the contact can be drawn where the calcareous Hershey yields to the noncalcareous shales of the Martinsburg. However, the former if often leached of its lime content. Another criterion for separation is based on the dark to black color of the Hershey, often even on weathered surfaces, while the Martinsburg commonly weathers olive to buff.

Character and distribution

Southwestward, the Hershey was observed in only small scattered outcrops to a few miles southwest of Harrisburg. North of the Bethlehem Steel quarry in South Steelton (Sec. 2), the basal dolomite conglomerate is well exposed in the road cut at the intersection of Chambers and Good Streets at the first sharp curve a few hundred feet east of U. S. Route 230. Several of the dolomite fragments are of boulder size, up to two to three feet, and somewhat angular. One boulder exceeded five feet. The basal Hershey Limestone, here locally leached of the lime content to form a fissile shale, contains numerous graptolites which have been distorted and stretched considerably due to movement along the bedding planes. This is the most easterly occurrence of graptolites observed by the writer at this horizon. However B. L. Miller (1925) has reported one graptolite specimen in the "cement rock" in the Coplay Cement Manufacturing Company quarry (N. E. rectangle of Allentown West quadrangle). Graptolites are fairly common west of the Harrisburg region at approximately the same stratigraphic position (Salona Limestone or basal "Martinsburg" of some authors).

At Steelton, the highly distorted forms could be identified only in part, and to genus only as *Climacograptus*. The significance of this fauna is discussed later. The overlying Hershey beds were fortuitously exposed in a ditch along the road leading north of the above exposure during the laying of a pipeline. The typical black, carbonaceous Hershey Limestone occurred through at least 400 feet along the road.

West of the Susquehanna River, the Hershey was observed in only a few small exposures. South of the Hempt quarry, the Hershey is exposed along Yellow Breeches Creek where the stream cuts through the axis of the overturned Steelton syncline comprising the Steelton and South Steelton belts. The Hershey is also exposed along the Pennsylvania Turnpike in the first road cut east of the Gettysburg Pike interchange. Here, it is readily distinguished from the basal Martinsburg on the limy content and darker weathering of the Hershey.



Columnar Sections of the Annville-Hershey Interval Along Nazareth Belt

Figure 14

In the Harrisburg belt, the Hershey was observed in Harrisburg along the north side of the Pennsylvania Railroad tracks a few hundred feet north of the intersection of U. S. Routes 322 and 230. The upper contact with the noncalcareous basal Martinsburg shale is fairly sharp in a small pit northward near Berryhill Street. Along the west bank of the Susquehanna River at Lemo Station (Sec. 9) a distance of only 1.5 miles from the above exposure the lower Hershey begins to grade into limestone of the Salona type (Figs. 6, 10, 16 and Sec. 9). More will be said concerning this relationship later.

Figure 15. Basal Hershey dolomite conglomerate directly south of Highway 322-422 and drive-in-theatre, about 0.5 mile south of Paxtang.

The Hershey is rather poorly exposed east of Harrisburg. The basal dolomite conglomerate was found in a field a few hundred feet south of the intersection of Spring Creek and Highways 322 and 422, 2.5 miles east of the Capitol, Harrisburg; and again about 0.6 miles farther east along these highways directly south of the drive-in theater, about one mile southeast of Paxtang, Harrisburg quadrangle (Fig. 15). Here, the dolomite conglomerate in places reaches boulder size. The upper Hershey is exposed a few hundred yards to the southeast at the first hill along Route 322 cutoff. The contact with the Martinsburg cannot be accurately determined here due to leaching of the calcareous content of the upper Hershey Limestone. The more resistant Martinsburg Formation forms the hill to the south. The Martinsburg commonly develops hills in this area with float usually covering the upper Hershey along the hill slopes. At Laurel Run (N. E. rectangle of New Cumberland quadrangle) the Hershey-Myerstown contact is exposed a few hundred feet along the road leading north of Goodville community. No basal Hershey conglomerate occurs locally.

Northeast of the type section (described earlier) one of the best exposures of

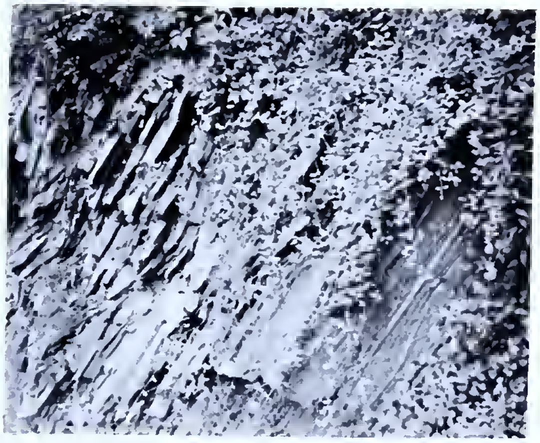


Figure 16. Exposure in road cut of Highway 11 at Lemoyne showing the contact of the alternating dense, black limestones and dark shale of the Oranda (left) and the carbonaceous, slaty limestone ("cement rock") of the Hershey. The beds are overturned and dip south.

:he Hershey in this area occurs along the east bank of Swatara Creek about one mile ıortheast of the square in Hummelstown. Unfortunately, neither the upper nor lower :ontact is exposed. Other than the cement rock quarries east of the Schuylkill River, :his is the best section encountered where one might observe fresh, unweathered Hershey Limestone. Along the line of high-calcium quarries from Hershey and Palmyra (Hummelstown quadrangle) to the vicinity of Myerstown, (Lebanon quadrangle) the Hershey Limestone occurs along the lower slopes of the low hills north of the quarries but exposures seldom show through the Martinsburg drift. One exposure was made during grading at the Swatara Plant of H. E. Millard, one mile west of Hershey (Fig. 17). The basal conglomerate was exposed along new Route 422, about one mile east of Stouchsburg. Here, the boulders of dolomite are quite angular, and occasionally attain several feet in diameter.

The Hershey becomes involved in complex structures in the Wernersville area and apparently disappears east of this area, the Martinsburg formation resting on Beekmantown for several miles to near the Schuylkill River where a thin belt of Hershey trends northward along the Schuylkill River, south of West Leesport, where the belt again ends along a tear fault (Gray, 1951). The type section of the "Leesport" Formation is at West Leesport, about one mile farther north, near the Schuylkill River (N. W. rectangle, Reading quadrangle). Miller (1937) has described the section in some detail indicating complex structure with folding and probably faulting present. The writer recognized four different types of rocks here: (1) dark, shaly, thin-bedded limestone; (2) massive, gray, creamy-weathering, sandy dolomite; (3) dark, thin-beoded, fine-grained limestone alternating with thin, gray shales; and (4) gray, brownish-weathering shale. Number 4 is

Figure 17. Weathered and contorted Hershey Limestone directly north of the abandoned Swatara quarry of H. E. Millard, one mile west of Hershey, Pennsylvania.

typical Martinsburg shale, and 2 and 3 are similar to limestone units observed in several localities within the Martinsburg Formation. Unit 1 has the dark, impure, dense lithology of the Hershey or upper Jacksonburg but lacks their usual prominent slaty cleavage. So it would appear that only about 75 feet of the type "Leesport", about half the total thickness could correctly be assigned to that formation. Moreover, the section includes no Myerstown or "cement limestone" type of lithology.

The general area of the Schuylkill River marks the beginning of the belt of cement rock quarries extending eastward to New Jersey. The Jacksonburg Limestone in this area (Hershey Limestone) has been described by Ralph Miller (1937). The "cement rock" here differs very little in appearance from the Hershey Limestone, but may have a few crystalline beds, and generally has the proper mixture of clay, lime, and other properties to be used for Portland cement. With few exceptions, noted earlier under the discussion of the Myerstown, the large quarries are developed only in the Hershey "cement rock". About 1.5 miles northwest of Moselem Springs, the Hershey rests disconformably on the Beekmantown, no basal conglomerate being present. Eastward, cleavage has mostly obliterated the bedding as in typical Hershey to the west. East of the Delaware River in New Jersey the "cement rock" of the upper Jacksonburg has undergone much less deformation in places. Due to the relatively small amount of cleavage, some areas are highly fossiliferous. At the type section at Jacksonburg (Sec. 7) the lack of slaty cleavage makes it possible to measure within a few feet the thickness of the upper Jacksonburg "cement rock": 71 feet. The exact contact with the Martinsburg is covered. Weller (1903) described the fauna with great detail and R. L. Miller (1937) has added to the faunal identifications. The upper Jacksonburg in the type area differs considerably from the Hershey equivalents west of the Delaware, the former being thinner, showing little slaty cleavage, and containing an abundant fauna. The above changes take place rather rapidly

ıt about the Delaware River. On the other hand, the Hershey shows only slight changes rom the Delaware River southwestward for many miles, a point that is significant in he Hershey - upper Jacksonburg relationship and will be discussed under a later heading.

Figure 18. Limestone and magnesium limestone conglomerate near the base of upper Jacksonburg Limestone, along Hope-Johnsonburg road, 1.2 miles northwest of Hope, New Jersey.

The wide spread conglomerate observed at the base of the Hershey is not bserved in the type section of the Jacksonburg, but conglomerate mentioned by Kümmel 1901) and R. L. Miller (1937) from several nearby localities near the middle of the acksonburg Limestone is interpreted by the writer as probably the same horizon near ie base of the upper Jacksonburg ("cement rock") and basal Hershey (Fig. 18). The onglomerate in Pennsylvania was observed in all the sections either as a single bed at ie base, or in a zone covering several feet up from the base of the Hershey Limestone. hough locally ephemeral, the conglomerate is regionally persistant and is probably the est regional marker bed at the Jacksonburg horizon. Limestone conglomerate observed ı places at the base of the Martinsburg as designated by Craig (1949) in south-central 'ennsylvania is thought by the writer to probably occupy the same horizon.

Age relations

Due to the paucity of fossils in the Hershey Limestone, correlations must be ased largely on lithic criteria. The abundant faunas of western New Jersey largely dis- ppear in Pennsylvania, an exception being *Prasopora simulatrix* which has been occasion- lly observed in several sections closely associated with the basal limestone and dolomite onglomerate. This form is particularly abundant toward the base of the upper Jackson- urg in western New Jersey. If the Hershey embodies most of the upper Jacksonburg of ew Jersey, as is thought to be the case, the age based on faunas (Weller, 1903 and Miller, . L., 1937) in the latter would equal, at least, part of the Hull (Kirkfield) and Sherman

Fall of the New York standard. *Prasopora simulatrix*, Sherman Fall age, occurs at Jacksonburg and 17 feet above the base of the upper Jacksonburg. The first appearance of *Prasopora simulatrix* is believed to represent early Sherman Fall age. If so, only the lower 17 feet of the type upper Jacksonburg could be assigned to the Kirkfield (Hull). Though the limestone conglomerate occurring at the base of the Hershey is not observed at the type section of the Jacksonburg, near-by occurrences of the conglomerate would indicate that it occurs near the base of the upper Jacksonburg. This appears to be the logical stratigraphic position also in view of the hiatus at this position established through faunal evidence. The writer believes that the conglomerate represents an horizon, or perhaps zone, regionally persistent into Pennsylvania and would suggest that the base of the Hershey is approximately the same age as the base of the upper Jacksonburg of New Jersey. Due to insufficient fauna, the Kirkland age of the lower Hershey cannot be definitely established. However, *Prasopora simulatrix* where found in a well developed zone has about the same position relative to basal Hershey as to basal upper Jacksonburg.

The Hershey would compare favorably on the basis of gross lithology, stratigraphic position, and, to the extent of *Prasopora simulatrix* fauna to the Salona Limestone also of central Pennsylvania, but may include, perhaps, some of the overlying Coburn equivalents. The lower part probably embodies the Oranda Limestone of Virginia, Maryland, and south-central Pennsylvania. It is of interest to note that the Oranda-Edinburg contact of Virginia, considered likely to be unconformable by Cooper (1946) shows the same general lithologic change at the contact occurring at the Hershey-Myerstown contact. Thus it appears the base of the Hershey is marked by a pre-Sherman Fall disconformity which is probably of regional significance. The hiatus is followed by dark, gray to black, shaly limestone, and preceded by gray purer limestone throughout this area. The widespread conglomerate above indicates the importance of this hiatus.

Status of the Jacksonburg Limestone

The similarities of the "cement limestone" and "cement rock" to the Myerstown and Hershey limestones in Pennsylvania have been, previously discussed. A comparison of the Myerstown and Hershey to the Jacksonburg Limestone of New Jersey indicate several megascopic as well as faunal differences. It further appears that the base of the Jacksonburg is older than the base of the Myerstown. Though the Jacksonburg is largely a correlative of the Myerstown-Hershey interval the differences are sufficient to warrant separate nomenclatural designations. These differences as previously indicated are lithologic and faunal. Also insufficient data are available to make direct comparisons of the lower Jacksonburg contact with the lower Myerstown contact.

The subdivision of the approximate Jacksonburg equivalents in Pennsylvania into formational units does not in itself necessarily call for the reclassification of the Jacksonburg Formation in New Jersey, although it would result in formations (Myerstown and Hershey) being partial equivalents of members (lower and upper Jacksonburg). The classification in Pennsylvania does not involve typical Jacksonburg. However, there is a separate problem as to the status of type Jacksonburg. If Weller (1903) is correct in assuming a Black River age for the lower, and Trenton age for the upper Jacksonburg, there is a good cause for erecting separate formation names for the upper and lower units, and abandonment or redefinition of the term Jacksonburg. If Miller (1937) is correct in assuming the Trenton age of the entire type Jacksonburg, a view favored by the writer, then there would be some cause to assign new names to the highly different lower and upper Jacksonburg, in which case the latter term might be elevated to group status; or alternatively, the subdivision might be assigned formal member names with the Jacksonburg maintaining its present formational status.

It should be recognized, however, that for reasons given earlier, a discon-)rmity probably exists between the lower and upper Jacksonburg. Thus the choice of ne name (Jacksonburg) to include units separated by a potential break might have been n unfortunate one. The name Jacksonburg is deeply bedded in the literature and has lso, unlike the "Leesport", been used in a consistent manner. For these reasons the ame Jacksonburg might best be preserved. However the terms lower and upper Jack- onburg should perhaps then be used more formally, in the formational sense, with the rm Jacksonburg Limestone being preserved as a stratigraphic terrain in a manner imilar to the subjacent Kittatinny terrain.

The Base of the Martinsburg

As indicated in figure 3, the basal contact of the Martinsburg Formation as been interpreted differently in various areas of Pennsylvania. The reasons for this re perhaps manifold. One of the difficulties lies in lithologic versus faunal inter- retations. The *Sinuites cancellatus* zone, used by Ulrich (1911) as a guide to the basal ontact was used by Craig (1949) in separating the Martinsburg from the Oranda in the entral belts. The *Sinuites* zone is followed by a graptolite-bearing dark shale. The tter zone is thought to represent the graptolite zone recognized by the writer at Steelton the basal Hershey. The thick metabentonite below (Sec. 2) could then fit Salona 2 meta- entonite which Craig has placed at the top of the Oranda. The Martinsburg base in the entral belts then has been placed lower stratigraphically than in the eastern belts and e contact is drawn to include dark shaly limestone of the general Hershey type within e Martinsburg. Eastward from Harrisburg, increased metamorphism has obliterated ost of the faunal evidence and the contact is drawn lithologically where the carbonaceous mestones (Hershey Limestone) yield stratigraphically higher into non-calcareous olive brownish, buff-weathering shale. Thus the basal Martinsburg contact as generally drawn stward from the Susquehanna River differs from the contact westward by the approximate terval of the Hershey Limestone. This relationship extends eastward into New Jersey here the contact is drawn at the top of the calcareous Jacksonburg.

The basal contact relationship is somewhat questionable due largely to the ry few good exposures across the contact. In the well exposed Hummelstown section ec. 3) the nature of the contact is largely obscured due to the well developed flow eavage, but it appears discordant by a few degrees. Miller (1937) indicates a question- le discordant, and also an accordant relationship near Martins Creek in eastern ennsylvania; the accordant occurrence showing distinct disconformity, however, raig (1949) likewise indicates disconformity at the base of the Martinsburg in south- ntral Pennsylvania, but this must correspond, because of correlative relations men- oned earlier, to the disconformity recognized at the base of the Hershey in eastern ennsylvania.

Insufficient exposures of the lower Martinsburg contact in eastern Pennsylvania ecludes the possibility of establishing the exact nature of the contact from a regional and point. Too few fossils exist in this area to further resolve the problem. On the sis of general lithologic comparisons with the fossiliferous rocks in central Pennsylvania, is likely the Hershey-Martinsburg contact would represent roughly the upper Salona ntact and therefore approximates upper Sherman Fall- Trenton in age (Fig. 10). Miller 937) indicates Jacksonburg deposition in western New Jersey must have continued well to Sherman Fall time, thereby inferring the age of the basal Martinsburg to be no older an late Sherman Fall. Basal Martinsburg could be younger than this, depending upon e time represented by the hiatus separating it from the Jacksonburg. Though the Jack- nburg is quite fossiliferous, basal Martinsburg fossils are too scarce to be of help in

this problem. There is no reason to assume a sizeable time-break at the contact although the sharp break in lithology and composition of the rock at the contact would indicate it unlikely transitional in New Jersey as well as eastern Pennsylvania.

PALEOGEOGRAPHIC CONSIDERATION

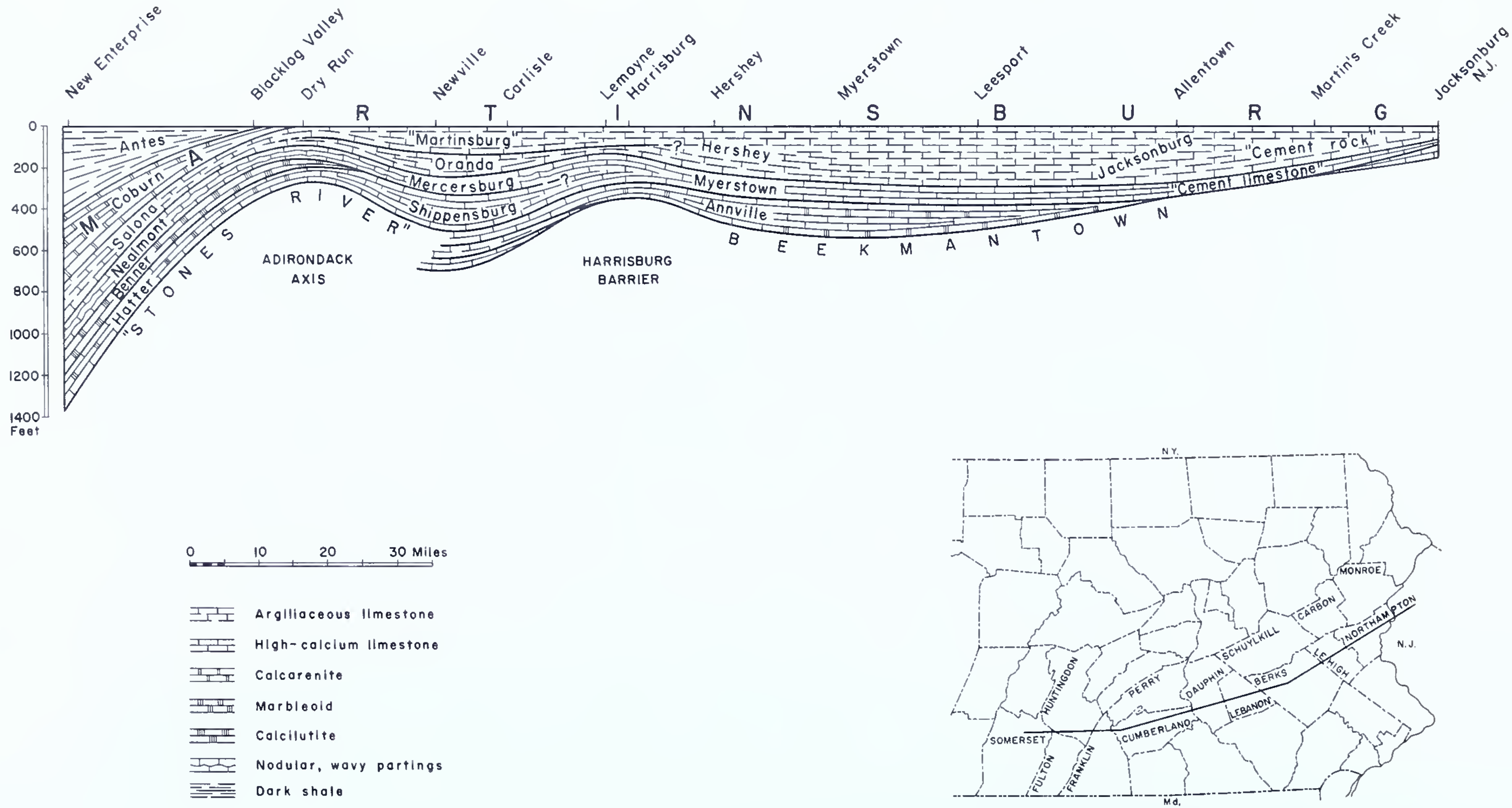
Major Structural Elements

The Annville, Myerstown and Hershey Limestones show marked east-west facies changes in the general environs of Harrisburg and the Susquehanna River. Typical "Chambersburg" lithology is not recognizable east of the river, but elements of upper "Chambersburg" (Mercersburg Limestone) are recognized in the Myerstown Limestone. Similarly, limestones of typical "Stones River" lithology west of the Susquehanna disappear rapidly east of the river, indicating a likely thinning of the lower and middle "Stones River" and a gradation of the upper part into the Annville facies. The sharpness of these changes infer a structural and facies barrier in the general Harrisburg area (Fig. 19).

Later Ordovician evidence for the structure is likely indicated by the disappearance of the Maysville phase of the Martinsburg in this general area.

The Lower Devonian Oriskany Sandstone disappears eastward in the northwest part of the Harrisburg quadrangle and is probably absent for several miles northeastward to northern Lebanon County. Ulrich (1911) proposed the name Harrisburg axis for this structure and assumed it to have a general northwest trend. Willard (1939) mentions the barrier and states that it was effective in Paleozoic times, especially during the Cambrian, Ordovician, and Silurian. The writer pictures the structure as a low broad linear structure trending north-northeast across the present structural belts which show an east-northeast trend. To the south of Dauphin County evidence of the structure is lost in the Triassic outcrop area. To the north, some evidence for the trend is observable in the distribution of the Oriskany based on outcrop and subsurface data in Northumberland, Columbia and Luzerne Counties. Woodward (1957) places considerable emphasis on this evidence in outlining a structure believed by him to be the southern extension of the Adirondack axis. The writer believes this southern extension to pass in the Black Log Valley Area much farther west. Woodward also believes the structure occupies the same structural trend as the Tazewell axis mentioned by Prouty (1948) in Virginia and Tennessee. There is sufficient evidence to assume intermittant activity along the "Harrisburg Axis" at least from Ordovician—Chazy to Devonian—Oriskany time.

Certain evidence points to a pre-Martinsburg structure in the area between Wernersville and Reading. Although faulting has been demonstrated in this area by Gray (1951) it was not inferred that all unconformable contacts are necessarily due to faulting. In fact, Gray (1952a) points to evidence for erosion in early Martinsburg time. Faulting alone would be insufficient to account for the distribution pattern of the Annville-Hershey interval. The Beekmantown is overlain without noticeable discordance by the Martinsburg at Sinking Spring; by Hershey north of Moselem Spring and at Evansville. Around Reading, Martinsburg rests on Conococheague; yet in Oley Valley about six miles to the east, a normal Annville-Hershey sequence may be observed in some places to separate the Martinsburg and Beekmantown. Erosion or nondeposition in post-Conococheague and pre-Martinsburg time is implied in this area. The wide distribution of the basal Hershey limestone and dolomite conglomerate indicates fairly wide spread erosion in pre-Sherman Fall-Trenton time. The dolomite boulders, of Beekmantown lithology,



Restored Section of the Annville-Hershey Interval

Figure 19

ıre exceptionally well developed in the basal Hershey of the Wernersville-Stouchsburg ɪelt west of this area and may reflect in part the erosion that removed all older rocks o the Conococheague in the general area of Reading. If so, this erosion obviously could ıot account for the absence of the younger Hershey Limestone in those parts of the gen- ral Reading area where Martinsburg rests on either Beekmantown or Conococheague, nd it appears Hershey deposition may not have occurred in the Reading area; indicating erhaps, offlap relationships along a structure brought about during an early Trenton plift. An alternative accounting could be the removal of the beds during the post-Her- hey, pre-Martinsburg interval, or even early Martinsburg as evidenced by Gray (1952a). 'his would not account for the erosion interval where Hershey is in contact with the eekmantown Group; nor for the erosion that brought about the basal Hershey conglomerate. lowever, the possibility of two periods of erosion cannot be discounted. Structurally, ıis area occurs in the "saddle" in the crystalline complex which forms the Reading Hills the northeast and South Mountain to the southwest. The widespread basal Hershey and ıid-Jacksonburg limestone and dolomite conglomerate could indicate pre-mid Trenton ctivity along this "Reading Arch" line from New Jersey to southeast Pennsylvania. Thus somewhat linear source for the interformational conglomerate is suggested rather than point source from the Reading area, although this area apparently evidenced greater plift and subsequent erosion.

ECONOMIC ASPECTS

Annville Limestone

Gray (1952) has discussed the high calcium limestone of Lebanon and Berks County, the principle area of quarrying for Annville Limestone. Though additional operations will likely follow along the Annville belt (Pl. 1), many problems exist, especially urban development, cultural features, and water problems both surface and underground.

It is unlikely that future large scale development will extend much farther southwestward into Dauphin County than the Ebersole quarry, Lower Swatara Township, about two miles north of Middletown, because of thinning and increased impurities in that direction. Some potentialities may exist within a mile or a mile and a half southwestward along the belt from this quarry, but considerable exploratory drilling would be necessary to test the grade, thickness, and overburden.

Northeastward of the main quarries in the Annville belt, the Annville thins in the Stouchsburg area of Berks County. Farther east to near Wernersville, the Annville is involved in complex structures.

Though the Annville loses its identity as a formational unit northeast of Wernersville along the same structural belt, the formation reoccurs in Oley valley some six miles east of Reading. The thickness and grade of the Annville is of the same order here as in the Annville district, and is being exploited at the present time by the Eastern Lime and Stone Company. The Oley valley area may prove to be an area of considerable potential to the future development of high-calcium limestone.

The Annville is important for a number of other uses including flux, agricultur. lime, aggstone and cement. It is likely that throughout most the area of its known extent it is of potential value for these products.

Myerstown Limestone

The Myerstown Limestone has a composition somewhat intermediate between t: high-calcium Annville and the highly impure Hershey Limestone. It is, therefore, inadequate as either a flux stone or natural source of Portland cement. However, it has been used locally to "sweeten" the Hershey where the latter becomes too impure for Portland cement grade, as in some of the Portland cement quarries of the Nazareth-Lehigh belt where the subjacent Myerstown is readily obtained merely through extending the quarries southward. Chemical analyses of the Myerstown as indicated by Gray (1951) from various parts of Berks County reveal the magnesium content generally too high for Portland cement in addition to the necessity for heavy blending with high-clay sources.

The limestone throughout the area east of Hummelstown would provide good aggstone. West of Hummelstown the body is quite variable both as to thickness and composition. West of the Susquehanna the Myerstown rapidly loses its identity as a formatio· al unit and passes laterally into the Chambersburg Limestone.

Hershey Limestone

The Hershey Limestone embodies the principle rock used in the Portland cement dustry. Variation in magnesium and silica content has precluded indiscriminate util-ation of the rock west of the Schuylkill River, the writer knows of no extensive explor-ion work in this area. Exposures are very limited due to Martinsburg shale float. :casional exposures, as along Swatara Creek, one mile north of Hummelstown; a mile d a half south of Hummelstown (Sec. 3); and at Steelton (Sec. 2) would indicate the :rshey to continue with thickness in order of 300 to 400 feet to the Susquehanna River. has the same megascopic appearance throughout this belt as far southwest as the ımmelstown area where it contains calcareous siltstones and sandstone in amounts :ceeding other sections observed. Insufficient data are available to determine to what :tent the sandy aspect persists between Hummelstown and the Susquehanna. However, e area between Hummelstown and the Schuylkill River would appear a more feasible ·ea for possible further testing for Portland cement rock.

MEASURED SECTIONS

Section 1

Palmyra Section
Section at the former Palmyra Plant of H. E. Millard
1.5 miles northeast of Hershey, Pa.

	Thickness in feet Unit:	Total:
Myerstown Limestone:		
Annville Limestone (180.5 ft):		
Limestone, dark, shaly, thinly laminated	5.0	195.5
Limestone, dark- to medium-blue-gray, fine to near-dense, weathers gray to white, granular	64.0	190.5
Limestone, black, carbonaceous, somewhat shaly	1.2	126.5
Limestone, dark- to medium-blue-gray, fine to near-dense, weathers gray to white, granular	62.0	125.3
Limestone, dark, dense; partly covered	11.0	63.3
Limestone, bluish-gray, quite pure, weathering light, granular	5.0	52.3
Limestone, dense to very fine	1.0	47.3
Limestone, light-bluish-gray, weathering light-gray, granular	4.0	46.3
Limestone, dark-blue, near dense	7.0	42.3
Limestone, light-bluish-gray, white weathering	6.0	35.3
Limestone, white, marbleoid, a few thin, grayish-blue laminae, weathers flour-like	1.8	29.3
Limestone, dark-blue, fine-grained, massive; 4" shaly bed near the middle	2.5	27.5
Limestone, light-bluish-gray, fine-grained, thin-bedded, weathers somewhat shaly	10.0	25.0
Beekmantown Group		
Dolomite, dark-gray, fine-grained, weathers brownish-gray; fetid odor (forms hanging wall, beds overturned)	15.0	15.0

Section 2

Steelton Section

Section at the north side of Bethlehem Steel Quarry
Steelton, Pennsylvania

	Thickness in feet	
	Unit:	Total:
artinsburg Formation.		
ershey Limestone (303-5 ft.):		
Limestone, black, carbonaceous, high clay content, slaty cleavage prominent; distorted graptolites, probably *Climacograptus* in lower few feet; estimated thickness	300	716.0 - 718.0
Conglomerate, dolomite, pebble to cobble size, in highly weathered, shaly limestone matrix; zone	3 - 5	416.0 - 418.0
yerstown Limestone (384.5 ft.):		
Covered	30	413.0
Limestone, bluish-gray, slabby weathering, crinoidal, with rough travertine surface	1.0	383.0
Metabentonite zone, buffish-gray clay and alternating chippy, buff shale	1.5	382.0
Limestone, blue-gray. crinoidal, compact, slabby	10.0	380.5
Limestone, same, largely covered	178.5	370.5
Limestone, thin-bedded, slabby weathering, dark blue to nearly black; fine- to medium-crystalline	43.0	192.0
Limestone, dark-bluish-gray; medium- to coarse-crystalline, massively ledged	1.0	149.0
Metabentonite zone, gray, buffish weathering, intermixed with buff, chippy shale, highly schistose locally due to slaty cleavage	2.0	148.0
Limestone, dark-grayish-blue, finely crystalline, with some coarsely crystalline beds, slabby weathering	5.0	146.0
Covered, columnar quartz float in soil	26.0	141.0
Limestone, dark-blue, slabby, mostly covered	18.0	115.0
Covered	31.0	97.0
Limestone, dark, thin-bedded to shaly; fault plane at top along slickensided footwall of large Bethlehem Steel quarry, displacement uncertain	37.5	66.0
nville Limestone (28.5 ft.):		
Limestone, medium-bluish-gray, with occasional fine, light-gray to white laminae; crushed and faulted zone near middle, displacement questionable	18.5	28.5
Limestone, blue- and light-gray-mottled, high-calcium, massively ledged	10.0	10.0

Beekmantown Group.

Section 3

Hummelstown Section

Type Section of Myerstown and Hershey limestones, 1.8 miles southwest of Hummelstown at Swatara Creek along Hummelstown-Middletown road.

	Thickness in feet Unit:	Total:
Martinsburg Formation.		
Hershey Limestone (435-8 ft.):		
Limestone, black, carbonaceous, impure, slaty cleavage, few silty limestone beds; estimated thickness	300	568.6 - 571.6
Covered interval, contains some exposures of limestone, buffy-brown, highly weathered and leached, black on fresh surface	135	268.6 - 271.6
Conglomerate zone, angular to sub-rounded dolomite pebbles, in a dark, shaly limestone matrix	0 - 3	133.6 - 136.6
Myerstown Limestone (56 ft.):		
Limestone, shaly; alternating with black, fissile, carbonaceous shale	18.0	133.6
Limestone dark-smoky-gray, thin-bedded, slabby, shows "fluting" on weathered surface	12.0	115.6
Limestone, dark-gray, thin-bedded, slabby	13.0	103.6
Limestone, shaly, carbonaceous some white, columnar quartz along bedding	3.0	90.6
Limestone, dark-gray, thin laminate, weathering into the rock along some laminae gives distinctive type of "fluting"; some columnar quartz	10.0	87.6
Annville Limestone (77.6):		
Limestone, dark-gray, few thin carbonaceous layers, weathers to smoky-gray	7.5	77.6
Limestone, gray, showing lighter gray "frosted" appearance on fresh fracture, high calcium	7.0	70.1
Limestone, bluish-white and bluish-gray striped	2.0	63.1
Limestone, gray and bluish-gray, mottled, high calcium	3.0	61.1
Limestone, dark-blue, weathers to smoky blue	6.0	58.1
Limestone, dark-blue with irregular, impure gray bands	12.5	52.1
Limestone, bluish-gray, finely crystalline	11.1	39.6
Limestone, light-gray with blue bands	2.8	28.5
Limestone, dark-blue, finely crystalline	2.5	25.7
Limestone, bluish-white and blue striped, occasionally mottled, highly "fluted on weathering	5.0	23.2
Limestone, dark-blue, finely crystalline	3.2	18.2
Limestone, bluish-gray- and gray-mottled, finely crystalline, high calcium	5.0	15.0
Limestone, white- and blue-striped, dense, high-calcium ..	6.0	10.0
Limestone, light-gray dense, high-calcium	0.5	4.0
Limestone, creamy white with bluish streaks (a good marker for basal Annville), aphanitic, weathered surface shows		

Section 3 (contd)

	Thickness in feet	
	Unit:	Total:
"fluting" with few thin laminae weathering into rock rather than standing out in relief as is commonly the case	3.5	3.5

Beekmantown Group:

Dolomite, creamy buff, massively ledged (contact with Annville discordant at 10°-15° angle).

Section 4

Swatara Plant Section

Measured section of the Annville Limestone, old Swatara Plant of the H. E. Millard Company, Hershey, Pennsylvania

	Thickness in feet Unit:	Total:
Myerstown Limestone:		
Limestone, dark-gray to black, impure, carbonaceous, shaly; columnar quartz; *Prasopora* at 2.8 feet, fragmented brachiopods at top; unit forms footwall of quarry	6.5	139.5
Covered.		
Annville Limestone (133.0 ft.):		
Calcarenite, dark-blue to black- and gray-speckled, coarse-grained massive ledged; limestone breccia, grains up to 1/2 in. in diameter	7.0	133.0
Limestone, dark-gray, shaly, laminated, carbonaceous	2.0	126.0
Calcarenite, dark-gray, medium- to coarse-grained, massive ledged	1.5	124.0
Limestone, dark-gray to black, slightly impure, carbonaceous; columnar quartz float	20.0	122.5
Limestone, light- to medium-gray, high-calcium, fine-grained, fractures with "frosted" bluish-gray appearance	12.0	102.5
Limestone, medium-bluish-gray, almost white on weathered surface; suggestion of fossil fragments near middle; columnar quartz float	43.0	90.5
Covered interval	8.0	47.5
Limestone, bluish-gray, laminae differentially eroded to give "fluted" appearance; fine-grained	11.0	39.5
Covered interval	10.0	28.5
Limestone, medium-gray, slightly magnesian, massive-ledged	3.5	18.5
Limestone, dark-gray- and medium-gray-mottled, high calcium, thinly laminated and fluted, fine-grained, weathers medium- to light-gray	15.0	15.0

Beekmantown Group.

Section 5

Millardsville Section
Composite section in old H. E. Millard quarry
at Millardsville 1 1/2 miles east of
Myerstown, Pennsylvania

Myerstown Limestone (partial section):	Thickness in feet Unit:	Total:
Limestone, dark-blue to black, very finely crystalline, few coarsely crystalline beds near top of section; one specimen of *Prasopora* near top; top of unit forms north wall of north extension of old quarry	50.0	203.0
Limestone, dark-grayish-blue, finely crystalline; some well developed clay and silt partings alternating with purer limestone to give banded appearance, often observed near base of the formation	17.0	153.0
Limestone, dark-bluish-gray, impure, slabby weathering	1.5	136.0
Limestone, black, carbonaceous, shaly	0.5	134.5
Limestone, dark-gray, impure, slabby weathering	6.0	134.0
Annville Limestone (128.0 ft.):		
Limestone, light-grayish-blue, finely crystalline, high in calcium	6.0	128.0
Limestone, light-gray, typical "frosted" appearance-high-calcium	50.0	122.0
Limestone, medium-gray, aphanitic to very finely crystalline; blue-gray and dark-gray bands giving a finely banded appearance	4.0	72.0
Limestone, medium- to dark-grayish-blue, mostly aphanitic, bluish-gray weathering, high-calcium	38.0	68.0
Calcilutite, medium-bluish-gray, "frosted" appearance, weathers light-bluish-gray with "fluted" surface, high-calcium, near conchoidal fracture	2.0	30.0
Limestone, medium-bluish-gray, nearly aphanitic	19.0	28.0
Calcilutite, mottled medium-gray and light-brownish-gray, weathers light-gray to chalky; mottled beds characteristic of basal Annville	9.0	9.0

Section 6

Stouchsburg Section
Short Section through Upper Myerstown
1 mile East of Stouchsburg, Pa., on U. S. 422
(after Carlyle Gray)

Unit	Thickness in feet Unit:	Total:
Covered at top		
Limestone, dark-bluish-gray, dense, beds 1/2 in. to 3 in. thick, some calcite veins; thin calcarenite at the base	4.6	82.3
Limestone, dark-bluish-gray, thin-bedded, weathers 7 in. somewhat shaly, few beds "fluted", upper partly covered	10.0	77.7
Limestone, dark-blue, weathered	4.0	67.7
Limestone, dark-bluish-gray, 1 in. to 4 in. beds; many calcite veins; calcarenite bed near top	27.1	63.7
Calcarenite, gray with pinkish cast, coarse-grained, unevenly bedded, 2 in. beds	0.9	36.6
Limestone, dark-bluish-gray, main calcite grains in a dense matrix	2.3	35.7
Calcarenite, thin-bedded	0.8	33.4
Limestone, dark, abundant calcite grains, nearly calcarenite	0.8	32.6
Limestone, dark-bluish-gray, a few sand size, calcite grains, 2 in. to 3 in. bed at base with calcarenite patches in blue matrix	7.2	31.8
Limestone, dark-blue, thin-bedded; also clay and metabentonite	2.0	24.6
Shale, yellowish-tan, sericitic, pyrite cubes	0.5	22.6
Clay, light- to dark-reddish-brown, earthy-probably leached impure limestone	0.8	22.1
Siltstone, greenish, hard, laminated; dark sericitic partings	0.8	21.3
Shale, tan, pyritic; probably metabentonite	0.8	20.5
Limestone, bluish-gray, dense, weathers to earthy clay	7.0	19.7
Shale, greenish, sericitic, bentonitic; alternating with 1/4 in. to 1 in. beds of dark-blue, dense limestone	0.9	12.7
Limestone, bluish-gray, scattered grains of calcite and patches of calcarenite	3.1	11.8
Clay, reddish-brown, earthy	0.4	8.7
Shale, greenish-gray to yellow sericitic; bentonitic	0.5	8.3
Clay, reddish-brown, earthy, with black manganese oxide	0.3	7.8
Limestone, blue-gray, massive, dense; some 1 in. clay seams; joint surfaces covered with manganese oxide	3.0	7.5
Metabentonite, involved in a drag fold, locally parallel to road	0.5	4.5
Limestone, metabentonite at base (may be above two units repeated)	4.0	4.0
Covered.		

Section 7

Jacksonburg Section
Type section of Jacksonburg Limestone at Jacksonburg, New Jersey, about 700 feet northwest of old mill

	Thickness in feet Unit:	Total:
Martinsburg Formation.		
Jacksonburg Limestone:		
Upper member (86.5 ft.):		
Limestone, dark, fine-grained, some dense, mostly impure; at 16 feet from base Dalmanella, *Dinorthis pectinella, Sowerbyella sericeous; Prasopora simulatrix* at 51 feet *Prasopora zygospira*	71.5	141.7
Covered interval	15.0	70.2
Lower member (55.2 ft.):		
Limestone, medium-gray on fresh and weathered surface, crystalline, becomes friable and "sandy" on weathering, quite fossiliferous, fossils (mostly brachiopods) preserved in chalky white material; limestone laminated	2.5	55.2
Limestone, dark, fine- to medium-crystalline	3.0	52.7
Calcarenite, dark gray and lighter gray mixed, dark glistening appearance, coarsely crystalline, very fossiliferous, mainly brachiopods and crinoid columnals, few trilobites fragments	1.0	49.7
Limestone, medium-grayish-blue, fine to medium crystalline	4.0	48.7
Limestone, dark-bluish-gray, very finely crystalline to aphanitic	4.2	44.7
Limestone, medium-gray, very finely crystalline to aphanitic, light-gray weathering, massive ledges	2.0	40.5
Covered zone	34.5	38.5
Limestone, finely crystalline to aphanitic	1.0	4.0
Limestone, bluish gray, but brownish-gray on fracture surfaces, in part calcarenitic, coarsely crystalline, planospiral gastropods, Bumastic fragments	3.0	3.0
Kittatinny Limestone.		

Section 8

Conodoquinet Creek
Located at covered bridge across Conodoquinet Creek, 2.4 miles southeast of Wertzville, southeast corner of southeast rectangle, New Bloomfield quadrangle

Martinsburg Formation.	Thickness in feet Unit:	Total:
"Martinsburg" Limestone:		
Limestone, black, carbonaceous, very fine-grained to aphanitic, brittle, compact weathering from slabby to fissile, only partly exposed	215.0	532.6
Oranda Limestone (317.6 ft.):		
Limestone, dark-gray to black, finely crystalline, weathering nodular to slabby with ash-gray surface, trilobite fragments.................................	19.0	317.6
Limestone, dark, very fine-grained to aphanitic; occasional buff irregular, impure partings at 30 feet from base; *Receptaculites* at 51 feet; ***Dinorthis***, ***Busmastus***	101.0	298.6
Covered interval	22.0	197.6
Limestone, dark gray to black, essentially aphanitic; in 1-2 in. beds; few buff wavy, impure partings; *Lophospira*, *Receptaculites*.......................	6.0	175.6
Covered interval	12.0	169.6
Limestone, dark-gray to black, compact brittle, essentially aphanitic, weathers somewhat nodular to slabby with a dull chalky-gray surface	32.0	157.6
Covered interval	9.0	125.6
Limestone, black, slabby weathering; *Oxoplecea*, ***Busmastus***, *Lophospira*	51.0	116.6
Metabentonite (?), buff clayey zone mostly filled with calcite.	0.2	65.6
Limestone, black, weathering to wavy slabs with chalky-gray surface; *Sowerbyella* ***Busmastus***..............	32.5	65.4
Metabentonite(?), dark-gray to buff, hard clay, splintery fracture	0.5	32.9
Limestone, dark, 2- to 3- in. bed with wavy partings, giving slabby to nodular appearance; ***Prasopora simulatrix***....................................	15.5	32.4
Metabentonite, buff, chippy to cuneate weathering........	1.9	16.9
Limestone, dark-gray to black, very finely crystalline to aphanitic, slabby weathering with dull chalky-gray surface	15.0	15.0

"Stones River" (fault contact, indefinite displacement, but probably small).

Section 9

Lemoyne Section
Section located at Lemoyne, Pa., directly across
Susquehanna River from Harrisburg, along
Pennsylvania R. R. tracks directly north of Lemo
Station,control tower

	Thickness in feet	
	Unit:	Total:
Martinsburg Formation.		
Shale, gray to olive,noncalcareous, occasional thin limestone.		
Hershey Limestone (65.0 ft.):		
Limestone, black, carbonaceous, shaly, fissile in places, brownish-gray weathering	65.0	129.4
Oranda Limestone (115.4 ft.):		
Limestone, black, very finely crystalline to aphanitic, brownish-gray, chalky weathering; thin dark shale partings	6.0	64.4
Covered zone, few exposures of limestone as above	3.5	58.4
Limestone, black, very fine-grained to aphanitic, thin platy beds; occasional thinner dark shale parting, highly stylolitic along jointing............................	12.0	54.9
Limestone, buff-creamy weathering, finely calcarenitic, finely laminated..	7.0	42.9
Limestone, dark-brownish-gray, chalky, thin dark shale aphanitic partings	6.0	35.9
Metabentonite(?), prominent break in outcrop, filled mostly with surface wash	0.3	29.9
Limestone, black, brownish-ash-gray weathering, aphanitic, occasional thin calcarenite; dark shale partings throughout	12.0	29.6
Limestone, thin calcarenites alternating with thin, fine- to medium-crystalline beds and thin shaly partings; weathers granular....................................	3.0	17.5
Calcarenite, fossiliferous, largely fragmented trilobites...	0.6	14.6
Mercersburg Limestone:		
Limestone, dark to nearly black, very finely crystalline, nodular to slabby in beds about 2 in. thick	8.0	14.0
Limestone, dark-blue, very finely crystalline; dark-ash-gray weathering; very fine, wavy, impure partings	6.0	6.0

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